GENETICS

Chapter 11

- ***Heredity*** =
  - Biological inheritance of traits
- ***Genetics*** =
  - Study of heredity
- Gregor Mendel
  - Father of genetics
  - Recognized patterns of inheritance of certain traits in pea plants
  - Why pea plants?
    - Easy to grow
    - Develop and reproduce quickly
    - Have many traits that take 1 of 2 easily distinguishable forms

Mendel Studied Transmission of Seven Traits in the Pea Plant

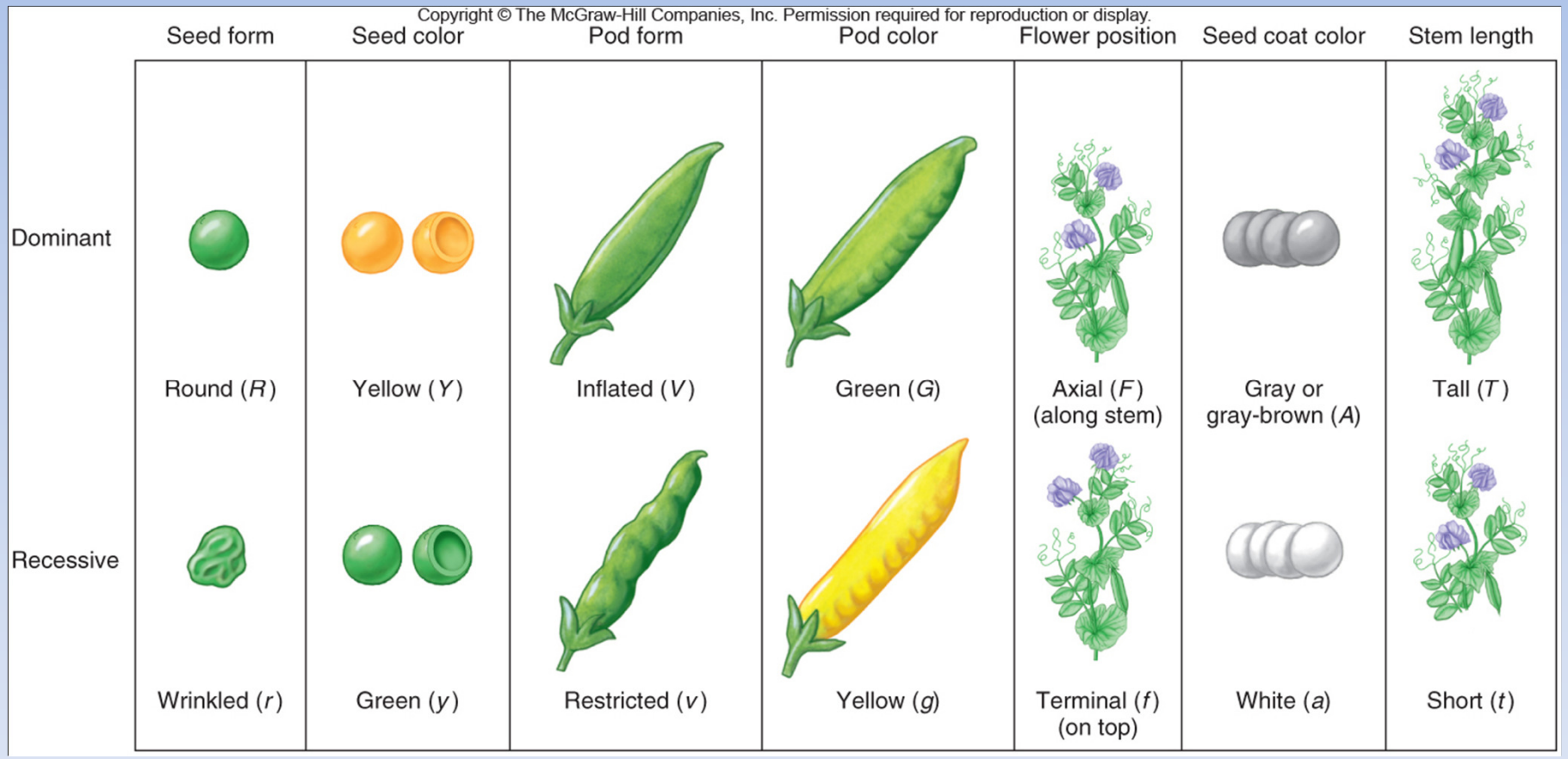


Figure 4.2

Figure 4.1

Vocabulary

- ***Gene*** =
  - Unit by which hereditary characteristics are transmitted from parent to offspring
  - Sequence of DNA that codes for a protein and thus determines a trait

- ***Alleles*** =
  - Various forms of a gene

- ***Dominant*** =
  - An allele expressed when present in one copy
  - Represented with a capital letter

- ***Recessive*** =
  - An allele whose expression is masked by another allele
  - Represented with a lowercase letter

- ***Homozygous*** =
  - Having 2 identical alleles of a gene
    - Either both dominant or both recessive
  - AKA “true-breeding”
  - Examples
    - TT
    - tt

- ***Heterozygous*** =
  - Having 2 different alleles of a gene
    - One dominant and one recessive
  - AKA “hybrid”
  - Example
    - Tt

- ***Genotype*** =
  - Genetic makeup of an organism
  - The allele combinations in an individual that cause particular traits or disorders
  - Ex: TT, Tt, tt
- ***Phenotype*** =
  - Physical characteristics of an organism
  - The expression of a gene in traits or symptoms
  - Ex: Tall, short
- Note: More than one genotype can produce the same phenotype
  - TT and Tt both = tall

Practice Examples:
Writing Genotypes and Phenotypes

Tall (T) is dominant over short (t)

Axial (A) is dominant over terminal (a)

Purple flowers (P) is dominant over white (p)

Tall (T) is dominant over short (t)

Axial (A) is dominant over terminal (a)

Purple flowers (P) is dominant over white (p)

Write the phenotype for each.

Tt	tall
aa	terminal
PP	purple
TTpp	Tall AND white
AaPp	Axial AND purple

Tall (T) is dominant over short (t)

Axial (A) is dominant over terminal (a)

Purple flowers (P) is dominant over white (p)

Write the genotype for each.

Homozygous axial = AA

Short = tt

Heterozygous purple = Pp

Heterozygous tall AND terminal = Ttaa

Homozygous tall AND homozygous purple = TTPP

Heterozygous white = Not possible!

Mendel's 1st Law

- ***Monohybrid cross*** =
  - A cross of 2 individuals who are heterozygous for a single trait
  - Results in phenotypic ratio of 3:1
- ***Law of segregation*** =
  - Alleles of a gene are distributed into separate gametes during meiosis
  - AKA: Mendel's 1st Law

Mendel's First Law – Segregation

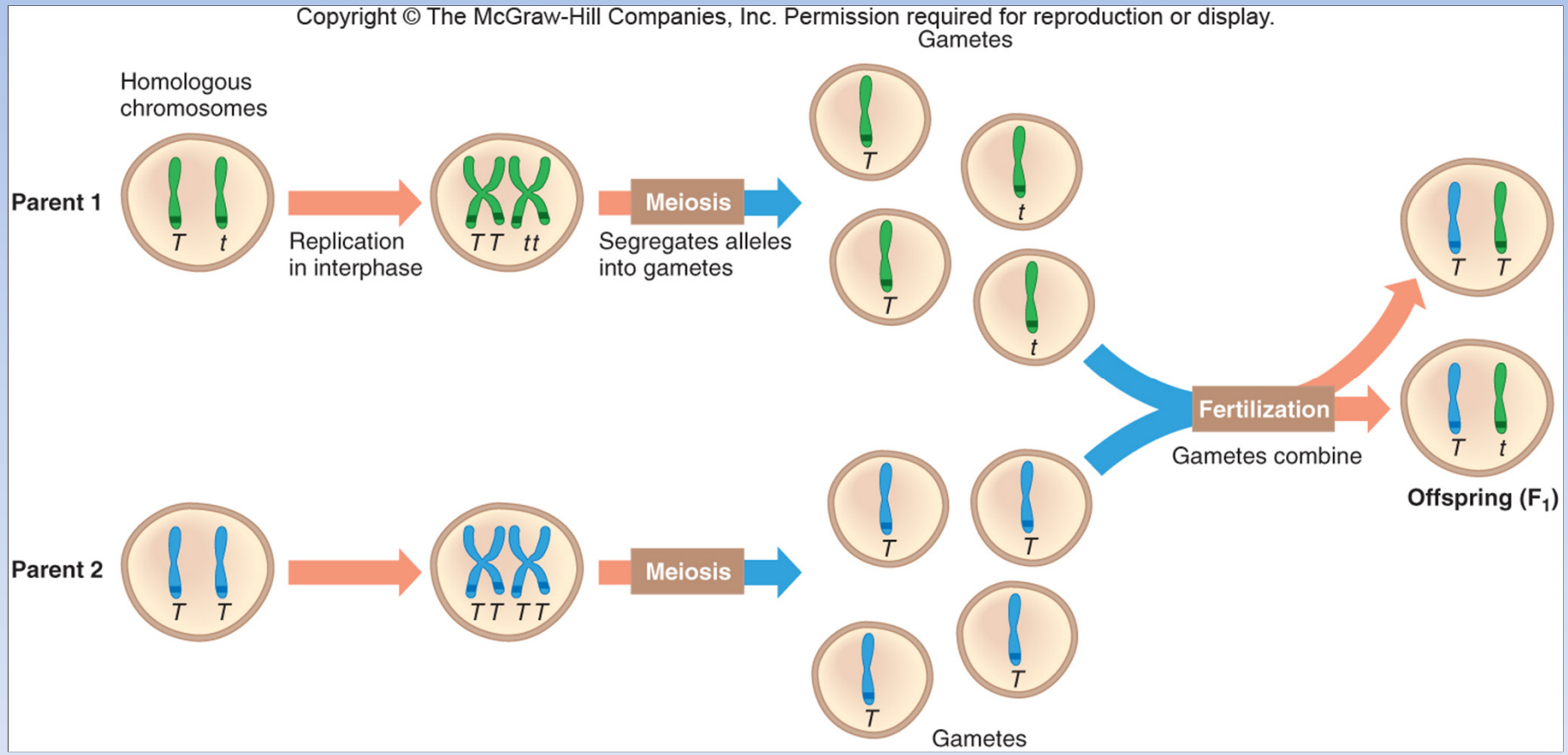


Figure 4.3

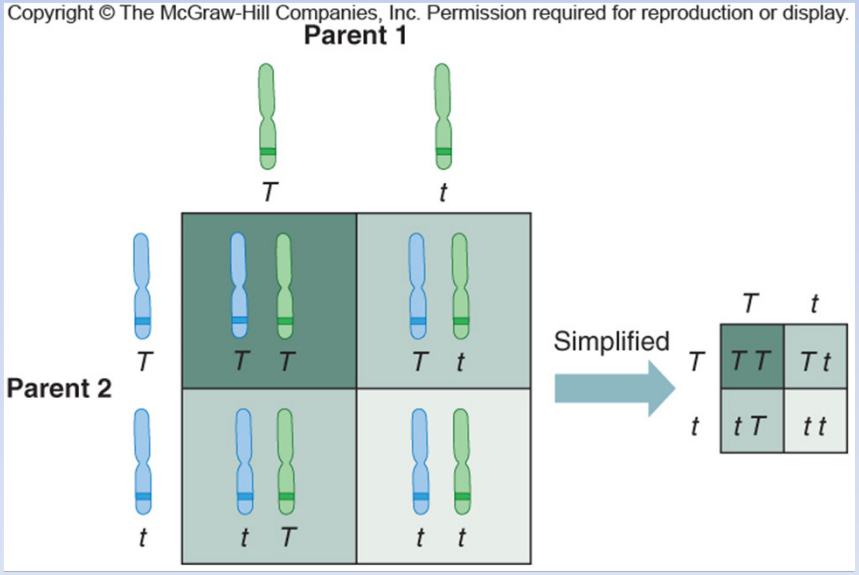
Practice Examples: 1 Trait

- ***Punnett Squares*** =
  - Represents particular genes in gametes and how they may combine in offspring

- Genotypic and

  Phenotypic Ratios
- Test Cross:

  Working Backwards



Mendel's Second Law

- ***Law of independent assortment*** =
  - Inheritance of a gene on one chromosome does not influence inheritance of a gene on a different chromosome
  - AKA: Mendel's 2nd Law
- ***Dihybrid cross*** =
  - Breeding individuals that are heterozygous for 2 traits
  - Results in phenotypic ratio of 9:3:3:1

Mendel's Second Law – Independent Assortment

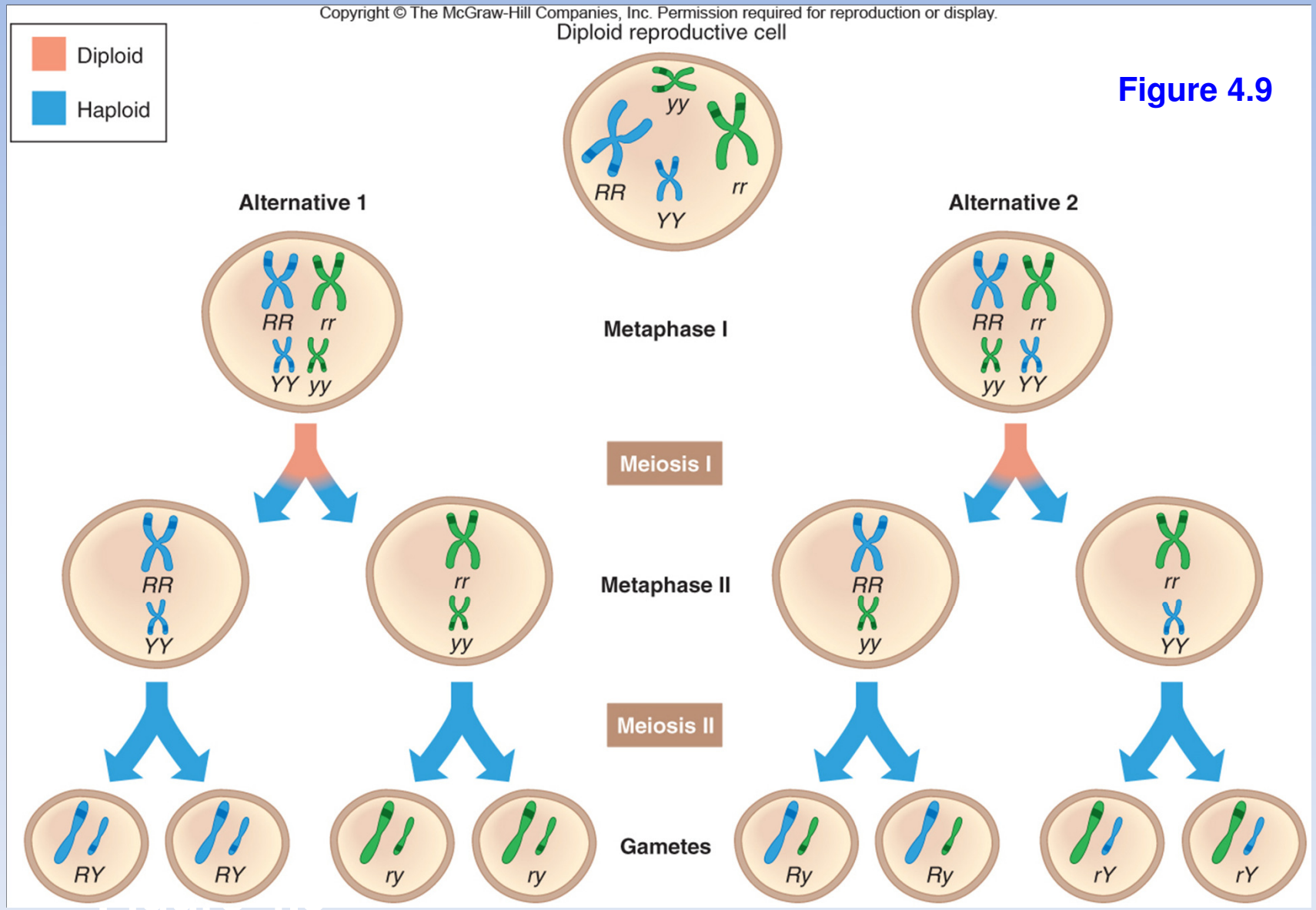


Figure 4.9

Mendel's Second Law – Independent Assortment

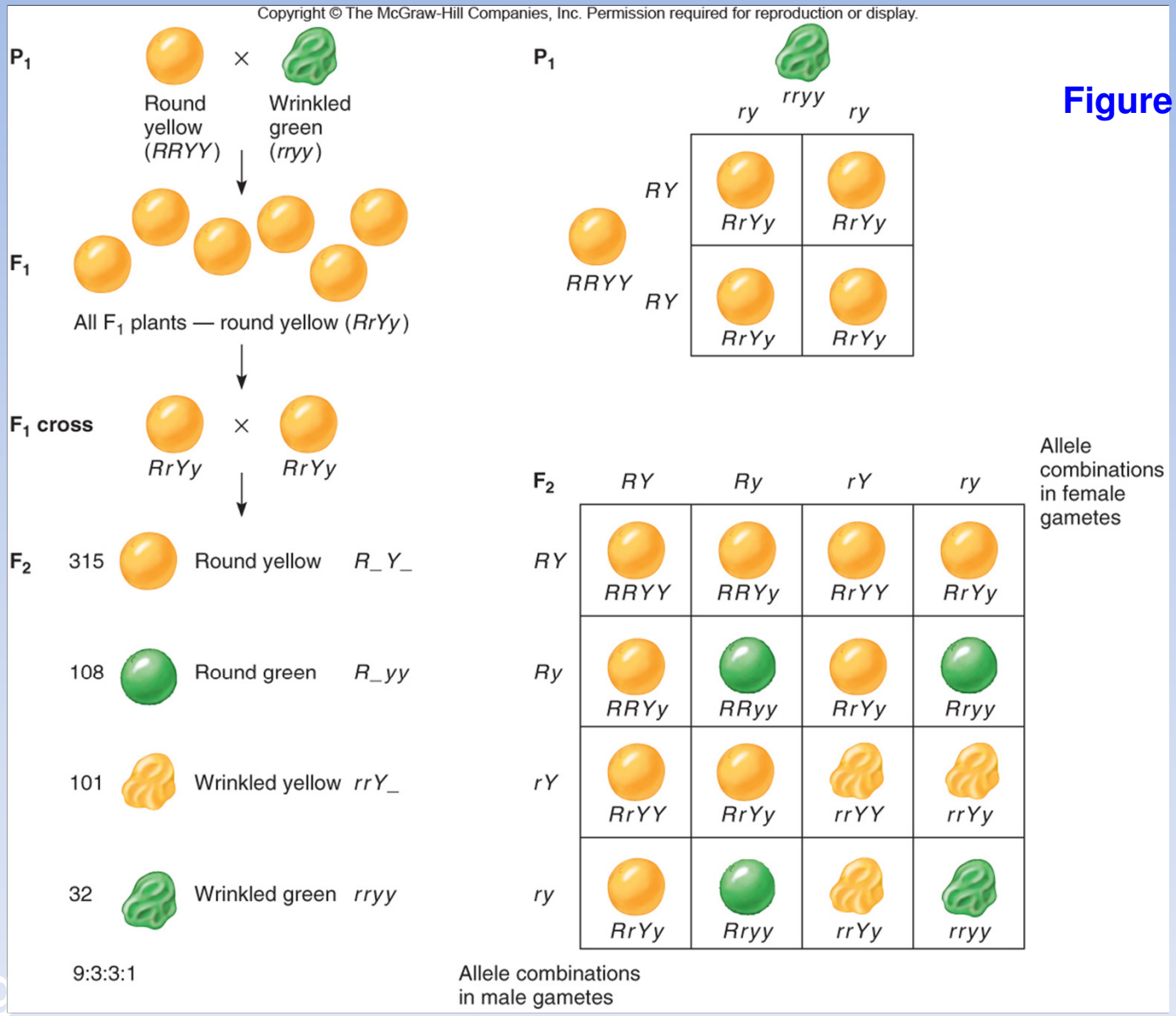


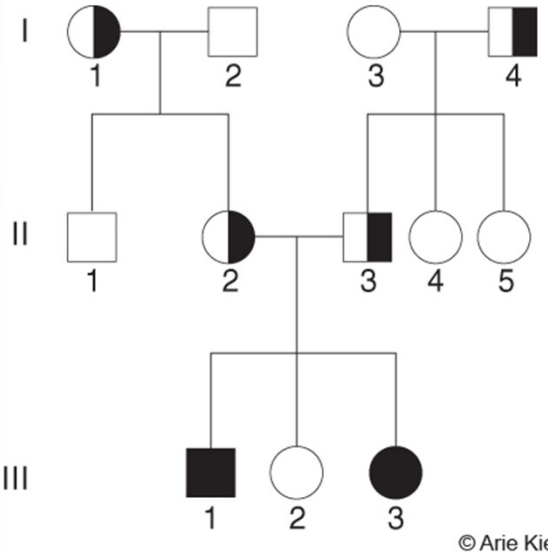
Figure 4.10

Practice Examples: 2 Traits

- Writing Genotypes and Phenotypes
- Punnett Squares
- Phenotypic Ratios

Pedigrees

- ***Pedigree*** =
  - Chart that shows inheritance of a trait over multiple generations

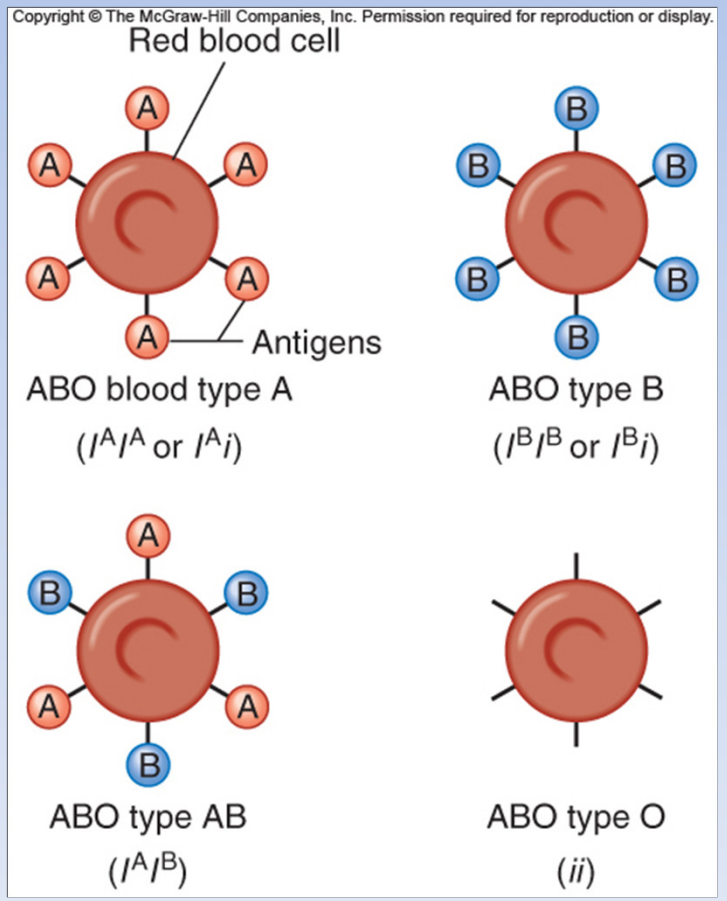


Other Patterns of Inheritance

- ***<u>Incomplete dominance</u>*** =
  - Neither allele is dominant, so rather than "masking," "blending" occurs
  - Ex: Color of Four-O'Clock Plant
    - RR = Red
    - WW = White
    - RW = Pink

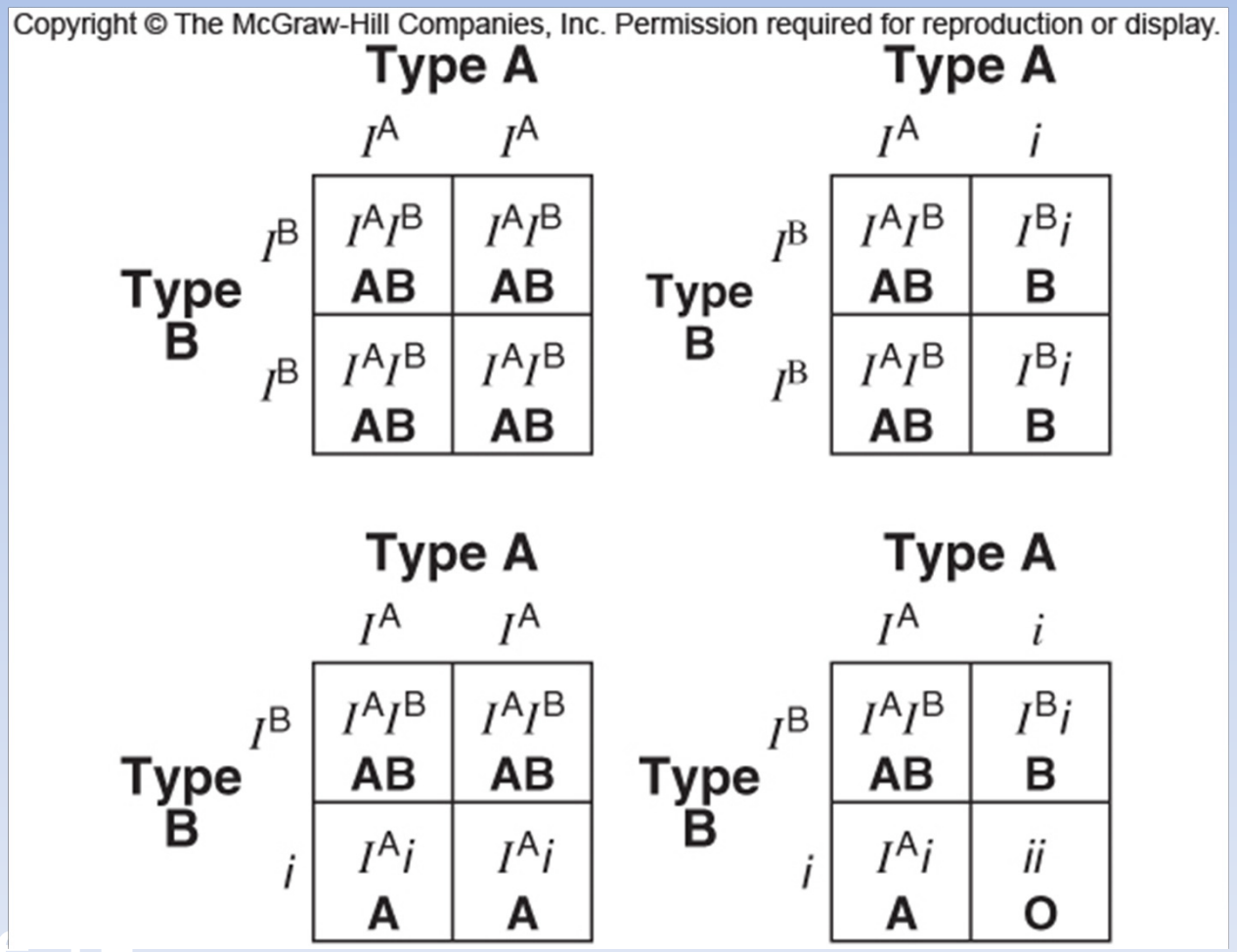
- ***Codominance*** =
  - Both alleles are fully expressed
  - Ex: Color of chicken feathers
    - BB = Black
    - WW = White
    - BW = Erminette (speckled black and white)

- ***Multiple alleles*** =
  - A gene that has more than 2 alleles
  - Ex: Blood Type
    - I^AI^A or I^Ai= A
    - I^BI^B or I^Bi= B
    - I^AI^B = AB
    - ii = O



Offspring from Parents with Blood Type A and Blood Type B

Figure 5.4



- ***<u>Polygenic traits</u>*** =
  - Trait controlled by 2 or more genes
  - Ex: Parakeet color
    - Green = B_Y_
    - Blue = B_yy
    - Yellow = bbY_
    - White = bbyy

Practice Examples: Incomplete Dominance, Codominance, Multiple Alleles, and Polygenic Traits

- Writing Genotypes and Phenotypes
- Punnett Squares
- Genotypic and Phenotypic Ratios
- Working Backwards

Sex-Linked Inheritance

Females = XX

Males = XY

- Y-linked traits are passed on the Y chromosome
  - Rare because the Y chromosome has few genes
  - Passed from male to male
- X-linked traits are passed on the X chromosome
  - NO male to male transmission
  - Passed just like autosomal traits in females
    - Two copies required for expression of recessive allele
    - One copy for dominant
  - Males are ***hemizygous*** =
    - Have only 1 set of X-linked genes
    - Single copy causes expression of trait or illness

Practice Examples: X-Linked Inheritance

- Writing Genotypes and Phenotypes
- Punnett Squares
- Genotypic and Phenotypic Ratios
- Pedigrees

Modes of Inheritance Recap

Autosomal Dominant

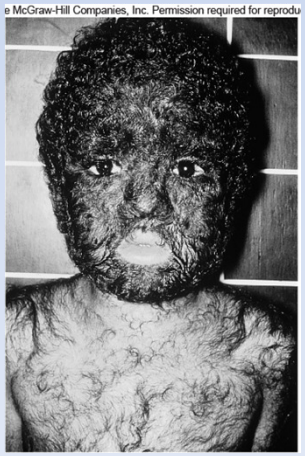
- One autosomal allele causes a phenotype
- Can affect males and females equally
- Does not skip generations
- Many diseases do not cause symptoms until adulthood
- Ex: Huntington disease

Autosomal Recessive

- Two autosomal alleles are required to cause a phenotype
- Can affect males and females equally
- Can skip generations through carriers
- Tend to be more severe and produce symptoms earlier
- Ex: Cystic fibrosis, Sickle Cell Disease

X-Linked Dominant

- Expressed in females with at least one copy
- Much more severe in males
- High rates of miscarriage due to early lethality in males
- Passed from male to all daughters but to no sons
- Ex: Congenital generalized hypertrichosis (Produces many extra hair follicles)



X-Linked Recessive

- Males only need 1 recessive allele to express trait
- Females need 2 copies of the recessive allele to express trait
  - Considered a carrier if they inherit one copy
- Sons inherit trait from mother who is affected or is a carrier
- Daughters inherit trait from affected father AND mother who is affected or is a carrier
- Ex: Colorblindness, Hemophilia B